Lake Boren Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2009

Lake Boren *Photo by KC Lake Stewardship Program*

Prepared for the City of Newcastle
by the King County Lake Stewardship Program

January 10, 2010

King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Lake Boren in 1994 and have continued to the present with gaps in 1995 through1996, and again in 2006. In 2005, City of Newcastle began contracting with KCLSP to fund the monitoring effort, including a separate study of fecal coliform bacteria. The longer term water quality data indicate that currently the lake has moderate productivity (mesotrophic) with fairly good water quality.

Although there is no longer a trailer-accessible public access boat launch, there is a large park on the south end of the lake where members of the public can launch small car-top boats and get into the water. The Washington Department of Fish and Wildlife continues to stock the lake with 1000 8-12" rainbow trout every year, in addition to 3,000 – 10,000 trout fry. Residents and lake users should keep a watch on aquatic plants growing near shore to catch early infestations of Eurasian milfoil, Brazilian elodea, or other noxious weeds. The lake is known to be infested with a non-native tape grass (*Vallisneria americana*), but it does not appear to be causing major problems as yet.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae present in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict what groups of algae may become dominant in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2009 water year. Specific water quality data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx

Or can be provided in the form of excel files upon request.

Physical Parameters

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

For Lake Boren, Secchi transparency values from May through October ranged from 1.3m to 4.8m, averaging 3.5m (Figure 1). This puts Lake Boren in the mid range of clarity for small lakes monitored in 2009. It appears as if water clarity increased at the end of spring and remained stable through summer, with the highest clarity in late August (note that the Y-axis is traditionally reversed on Secchi charts to mimic looking into the water). Into the autumn, clarity decreased due to late season algae blooms.

Compared to data collected in previous years, the Secchi transparency values exhibited normal variability through the season.

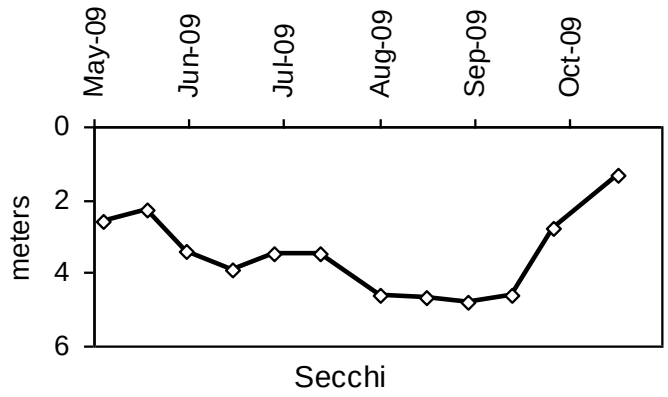

Figure 1. Lake Boren Secchi Transparency

Water temperatures during the May-October sampling period generally followed a pattern similar to other lakes in the region, with the cool temperatures recorded in the Spring of 2009 reflected in shallow water temperature, followed by summer maximum temperatures occurring between mid-July and mid-August and progressive cooling in the fall (Figure 2). The water temperature at Lake Boren ranged from 13.5 to 27.5 degrees Celsius with an average seasonal temperature of 19.9 degrees Celsius. The peak in early August could be attributed to the very hot weather experienced in the Puget Sound lowlands through July 2009. Compared to other lakes monitored through the KCLSP, Lake Boren was generally in the higher range of summer temperature maxima for shallow water.

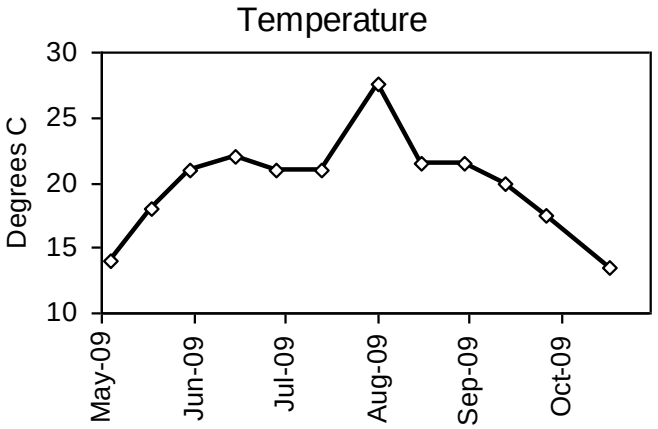

Figure 2. Lake Boren Water Temperatures

Nutrient and Chlorophyll Analysis

Phosphorus and **nitrogen** are naturally occurring elements necessary in small amounts for both plants and animals for healthy growth and reproduction. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms, which are a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth between May and October, with deeper water analyzed twice through the season.

Total phosphorus (TP) and total nitrogen (TN) both showed some variation through the May – October sampling period (Figure 3). In 2009 the TN values were elevated in spring, lowering through the end of August and then increasing again in the fall, with the highest value of the season recorded on the last sample date. TP values were low throughout the spring, but began increasing slightly in late August and continued the climb through the end of the sample period, also with the highest value recorded on the last sample date, concurrent with a fall algae bloom.

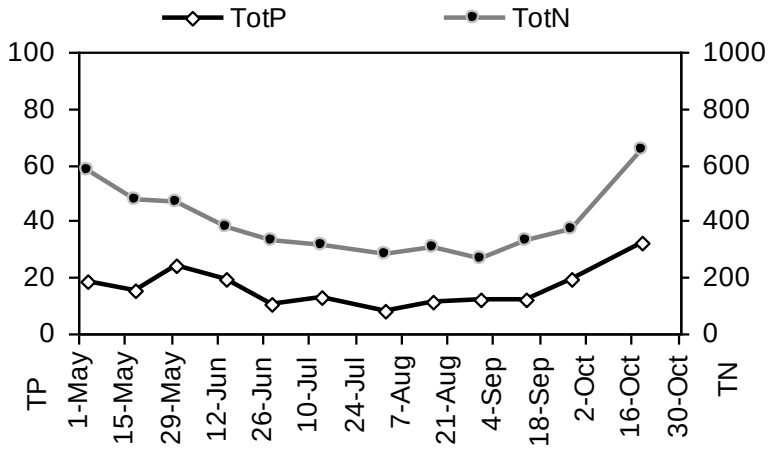

Figure 3. Lake Boren Nutrients

In 2009, the N:P ratio varied from 18.9 to 36.6 with an average of 25.9, which reflects conditions in the lake as slightly unfavorable for bluegreen algae growth, but close to the threshold for favoring bluegreens. However, there were 2 dates with N/P ratios below 20 in spring and 2 more dates in the fall, which signaled that conditions favoring bluegreen blooms were present at times during the monitoring period.

Chlorophyll *a* values were fairly low throughout the spring and early summer at Lake Boren (Figure 4). However, it increased dramatically from late September through October, concurrently with the nutrient increases, indicating that algae were able to reproduce quickly in the fall when the N:P ratio was lowest.

Pheophytin, which is degraded chlorophyll, remained low throughout the majority of the season.

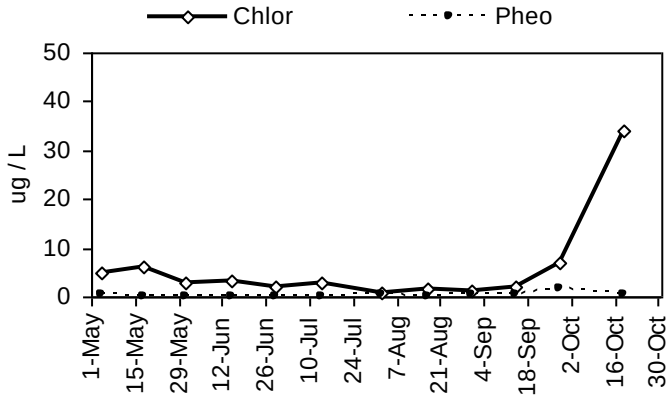

Figure 4. Lake Boren Chlorophyll *a* and Pheophytin Concentrations

The deep water temperatures during the first profile event were not recorded, but on the August profile date the lake was thermally stratified. Nutrients were higher in the bottom water in the August profile than during May (Table 1). However, the values are not high enough in either of the profile events to suggest that elevated phosphorus release from the sediments was significant. The presence of increased amounts of ammonia (NH3) suggests that oxygen depletion was occurring in the deep water through the summer. In addition, there was an increase in chlorophyll-a in the August deep water sample, which suggests that enough light was reaching the deeper water to stimulate growth of a benthic algae population.

Table 1: Lake Boren Profile Sample Analysis Results

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NO2-3	NH3	Total P	OPO4	UV254	Total Alk
Boren	5/18/09	2.3	1	18.0	6.2	**<MDL**	0.475	0.134	0.010	0.0155	**<MDL**	0.142	61.2
			5		8.2	1.4	0.701	0.352	0.037	0.0218	0.0022		
			9		1.5	2.1	0.795	0.507	0.032	0.0161	0.0026		
Boren	8/31/09	4.8	1	21.5	1.4	**<MDL**	0.268	**<MDL**	0.007	0.0122	**<MDL**	0.122	62.7
			5	16.0	7.0	1.8	0.361			0.0245			
			9	6.5	14.5	ChlorB	1.150	**<MDL**	0.831	0.0428	0.0041		

The Trophic State Index

A common method of tracking water quality trends in lakes is by calculating the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of the lake based on water clarity (Secchi), in addition to measured concentrations of Total P and chlorophyll *a*. In Lake Boren, all of the 2009 TSI indicators were very close to each other in the low mesotrophic range. The indicator record suggests that the lake is currently stable in terms of nutrient concentrations, with no obvious changes or trends over the years of measurement. The average of the three TSI values places the lake solidly in the lower mesotrophic range through the later years of monitoring, although it was higher in the mid 1990s (Figure 5).

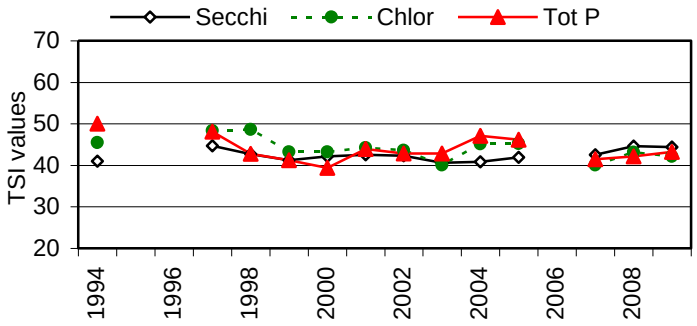

Figure 5. TSI Values at Lake Boren

Conclusions and Recommendations

Based on monitoring data, water quality as measured by nutrients and chlorophyll in Lake Boren has been stable over the last decade. There appears to be a pattern of elevated early season TN values that decline through the season, followed by increases in both the late season TN and TP values, that result in lower N:P ratios at the end of the summer. This indicates that conditions may favor nuisance bluegreen algae blooms in late summer through fall. Continued monitoring of nutrient and chlorophyll concentrations should be done to assess conditions annually to make sure that stability is being maintained long term. Algae blooms in the future should be reported for evaluation by the Washington State Department of Ecology's Toxic Algae Monitoring Program to determine whether or not blooms at the lake may be producing toxins.

The City of Newcastle also has contracted with KCLSP to perform fecal coliform analysis in addition to bimonthly growth season monitoring. A separate summary report has been written discussing the results and conclusions of that effort.